Capacitance	**Charging capacitors**

Learning objectives	**MUST (C)**	Recall the equation for the discharge of capacitors and the meaning of time constant
	SHOULD (B)	Explain and apply the equation for current and p.d. when charging capacitors
	COULD (A/A*)	Apply capacitor equations to PPQ style questions

STARTER: In our last lesson, we looked at capacitor discharge. Capacitors discharge through a resistor; how and why can we control the speed of discharge by varying the resistor?

EXTENSION: How could you redesign a defibrillator to make it safer for use on children?

Capacitance	**Capacitors 4**
MUST (C)	Recall the equation for the discharge of capacitors and the meaning of time constant

We can recall that: $Q = Q_0 e^{-\frac{t}{CR}}$ (Q can be replaced with V or I)

When t = CR, the equation reads: $Q = Q_0 e^{-1}$

e^{-1} is approx. 0.37; so at t = CR $Q = 0.37Q_0$

$$\frac{Q}{Q_0} = e^{-\frac{t}{CR}} \qquad ln\left(\frac{Q}{Q_0}\right) = -\frac{t}{CR}$$

[redacted]

1. A 100 μF capacitor being discharged through a 1.5 MΩ resistor has an initial charge of 3C. What is its charge at 250 seconds?

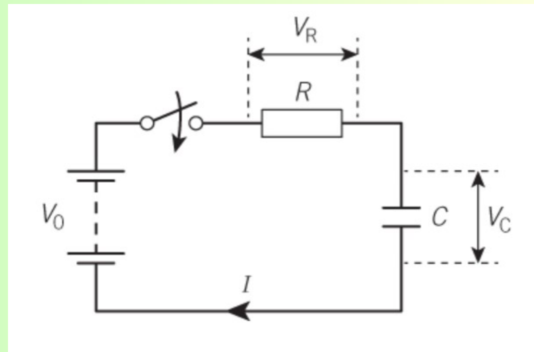
2. The same capacitor is discharged through another resistor. It takes 200 seconds for the charge to halve. Approximately what is the resistor's value?

[redacted]

Capacitors	**Capacitance 4**
SHOULD (B)	Explain and apply the equation for current and p.d. when charging capacitors

Charging a capacitor is also an exponential process; the rate of charge is initially fast, but drops with progressive charging.

When the switch S is closed, the capacitor charges. Initially, the current flow is high, as electrons move onto the capacitor plates. As the p.d. across C increases, the current decreases.



When p.d. across C = V_0, I = 0.

$$I = I_0 e^{-\frac{t}{CR}}$$

How will the p.d. across the resistor vary?

As V = IR.......

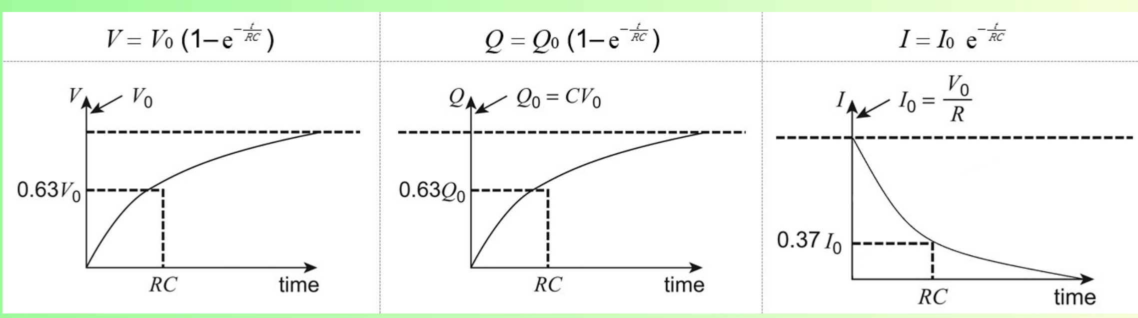
$$V = V_0 e^{-\frac{t}{CR}}$$

We know that $V_R + V_C = V_0$, so

$$V_C = V_0 - V_R$$

$$V_C = V_0 - V_0 e^{-\frac{t}{CR}}$$

$$V_C = V_0(1 - e^{-\frac{t}{CR}})$$



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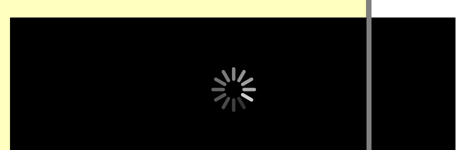
Capacitance	**Capacitors 4**
COULD (A/A*)	Apply capacitor equations to PPQ style questions

First, work through the summary questions 21.5. Then try the PPQs.



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Capacitance	**Charging capacitors**

Learning objectives	**MUST (C)**	Recall the equation for the discharge of capacitors and the meaning of time constant
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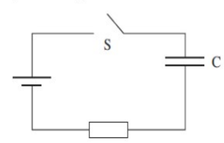
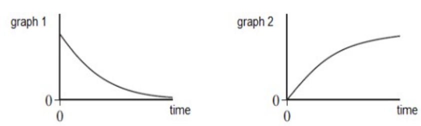
PLENARY:

D

In the circuit shown the capacitor C charges when switch S is closed.

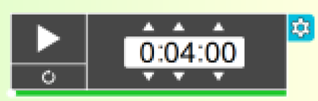


Which line, **A** to **D**, in the table gives a correct pair of graphs showing how the charge on the capacitor and the current in the circuit change with time after S is closed?



	charge	**current**
A	graph 1	graph 1
B	graph 1	graph 2
C	graph 2	graph 2
D	graph 2	graph 1

(Total 1 mark)



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